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Discharge Education Improves Clinical Outcomes in Patients With Chronic Heart Failure

Todd M. Koelling, MD; Monica L. Johnson, RN; Robert J. Cody, MD; Keith D. Aaronson, MD, MS

Background—Although interventions combining patient education and postdischarge management have demonstrated benefits in patients with chronic heart failure, the benefit attributable to patient education alone is not known. We hypothesized that a patient discharge education program would improve clinical outcomes in patients with chronic heart failure.

Methods and Results—We conducted a randomized, controlled trial of 223 systolic heart failure patients and compared the effects of a 1-hour, one-on-one teaching session with a nurse educator to the standard discharge process. Subjects were contacted by telephone at 30, 90, and 180 days to collect information about clinical events, symptoms, and self-care practices. The primary end point of the study was the total number of days hospitalized or dead in the 180-day follow-up period. Subjects randomized to receive the teaching session ($n=107$) had fewer days hospitalized or dead in the follow-up period (0 and 10 days, median and 75th percentiles) than did controls ($n=116$, 4 and 19 days; $P=0.009$). Patients receiving the education intervention had a lower risk of rehospitalization or death (relative risk, 0.65; 95% confidence interval, 0.45 to 0.93; $P=0.018$). Costs of care, including the cost of the intervention, were lower in patients receiving the education intervention than in control subjects by \$2823 per patient ($P=0.035$).

Conclusions—The addition of a 1-hour, nurse educator–delivered teaching session at the time of hospital discharge resulted in improved clinical outcomes, increased self-care measure adherence, and reduced cost of care in patients with systolic heart failure. (*Circulation*. 2005;111:179-185.)

Key Words: heart failure ■ patients ■ trials ■ patient education

Physicians treating patients with heart failure due to left ventricular systolic dysfunction must prescribe a complex treatment plan involving multiple medications and rigorous self-care practices to achieve optimal care. To summarize the goals of heart failure care, clinical practice guidelines have been published by several organizations, including the Heart Failure Society of America and the American College of Cardiology/American Heart Association.¹⁻³ In addition to the importance of pharmaceuticals, guidelines have recognized the importance of patient self-care measures.

Although these organizations agree that patient education is an important element in the care of patients with heart failure, no specific recommendations are given with regard to the amount or content of the information necessary to be effective. Previous studies evaluating the effect of heart failure patient discharge education combined with various postdischarge support programs have demonstrated benefits with respect to reductions in hospitalizations and costs.⁴⁻⁸ A recent meta-analysis of these studies found a trend toward reduced mortality with these interventions.⁹ To date, no studies isolating the effect of patient education on clinical outcomes in heart failure patients have been performed.

Methods

Subjects

This study was performed at the University of Michigan Hospital and was approved by the Medical School Institutional Review Board. Study subjects were recruited from the inpatient services of the hospital from April 2001 through October 2002. Candidates for this study were admitted to the hospital with a diagnosis of heart failure (International Classification of Diseases, 9th ed [ICD-9-CM] 402.1, 402.11, 402.91, 404.01, 404.91, or 428.x) and documented left ventricular systolic dysfunction (ejection fraction ≤ 0.40).

A total of 590 subjects with heart failure and left ventricular ejection fraction ≤ 0.40 were screened for enrollment into the study during the recruitment period (Figure 1). Of those screened, 367 were excluded from enrollment. The most common reasons for nonenrollment included evaluation for cardiac surgery (63), noncardiac illness likely to increase 6-month mortality or hospitalization risk (59), and inpatient cardiac transplantation evaluation (57).

Study Design

After written, informed consent was obtained, a random number was generated by a computer program and was used to assign patients to receive usual care (standard discharge information, controls) or usual care plus patient-targeted heart failure education (education group). Treatment assignment was concealed from the patients and study personnel until after the randomization step. The care providers for

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From the Division of Cardiovascular Medicine, Department of Internal Medicine, University of Michigan, Ann Arbor.

Correspondence to Todd M. Koelling, MD, 1500 E Medical Center Dr, Women's L3623, 0271, Ann Arbor, MI 48109. E-mail tkoellin@umich.edu
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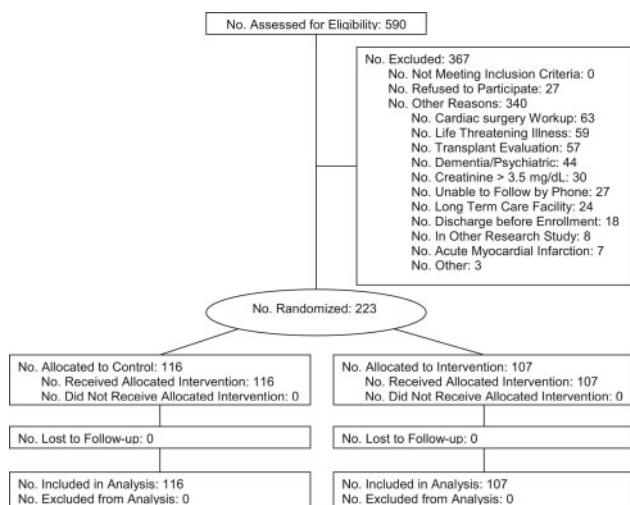


Figure 1. Patient screening and randomization assignment profile.

the patient in the hospital and in the outpatient arena were not informed of the treatment assignment.

Standard written discharge information was delivered in a folder by the assigned ward nurse at the time of discharge. This information included a list of medications, dosages, and instructions for taking the medications. An information sheet for each medication was given to each patient describing drug/food interactions and potential side effects (CareNotes System, MICROMEDEX). The standard discharge information also included dietary instructions, daily weight instructions, pneumococcal/influenza vaccination information, activity instructions, and follow-up appointment information. The folder also included a description of common heart failure symptoms and instructions on when to call the physician if symptoms worsened. A heart failure patient information booklet was also available for distribution to patients admitted to the hospital with heart failure.¹⁰ Monitoring showed that heart failure–specific discharge information was delivered to 74% of patients treated during the study enrollment period. As part of usual care, it is likely that patients received additional teaching from resident and staff physicians, nurses, and dietitians, although this could not be controlled or quantified. Follow-up after hospital discharge was left to the discretion of the inpatient medical team.

The patient education program included a 60-minute-long, one-on-one teaching session with a nurse educator before discharge. The nurse educator discussed heart failure–specific information that covered the basic principles of the causes of heart failure and rationale for pharmaceutical therapies. The education session contained material covering the causes of intravascular volume overload in heart failure and the mechanism of action of diuretic medications. The role of dietary restriction of sodium and limitation of dietary free water intake was also covered. Specific instruction was given to reduce daily dietary sodium intake to 2000 mg or less and daily fluid intake to 2000 mL (≈ 64 oz) or less, unless otherwise specified by the patient's physician. Additionally, the patient education session contained the rationale for self-care behaviors: daily weight monitoring, smoking cessation, avoidance of heavy alcohol intake and nonsteroidal antiinflammatory drugs, and what to do if symptoms worsened. Patients in the education arm of the study were also given a copy of the treatment guidelines for heart failure treatment written in layman's terms.

At the time of enrollment and by telephone at 30, 90, and 180 days after discharge, patients were administered scripted questionnaires addressing hospital admissions, medications, heart failure–related quality of life (Minnesota Living with Heart Failure Questionnaire [MLHF]), and knowledge of heart failure self-care practices. No treatment advice or additional patient education was provided at the time of follow-up telephone calls.

Costs for hospital readmissions were estimated using Medicare diagnosis-related group (DRG) reimbursement rate estimation software (IRP, Inc). For each hospitalization, the ICD-9 primary diagnosis, secondary diagnoses, and major ICD-9 procedure codes were entered to derive the appropriate DRG reimbursement. Adjudication of hospitalization events and DRG assignment was performed in a manner blinded to treatment assignment. All costs were estimated on the basis of 2003 Medicare reimbursement figures. The cost of intervention was calculated by assuming the need for 2 hours of clinical nurse educator time for each patient, estimated at \$50 per hour. An assumption was made that the nurse educator would require 1 hour to find eligible cases and to review the patient record before the education session and 1 hour to deliver the education program. Costs associated with screening, randomization, data collection, and follow-up were not included in the analysis.

Statistical Analyses

All analyses were performed (T.M.K., K.D.A.) with SPSS version 10.0 statistical software. The prespecified primary end point of the study was the number of days hospitalized and/or dead in the 180-day follow-up period. Comparison of the distribution of days hospitalized and/or dead for the 2 patient groups was performed with the Wilcoxon rank-sum test. Secondary end points for the study included (1) time to death or first hospitalization, (2) time to rehospitalization for cardiac causes, (3) time to rehospitalization for worsened heart failure, (4) quality of life scores, (5) self-care behaviors, and (6) costs of care. Cox proportional-hazards analysis was used to calculate the relative risk of time to a first event for the education patients, using the control patients as a reference. An additional Cox proportional-hazards analysis was performed to adjust for the mean arterial pressure of the patients by forcing mean arterial pressure into the model. For subgroup analysis, the stratification variable and interaction terms were entered into the Cox model along with the randomization assignment variable. Comparisons of categorical variables were performed by χ^2 tests. Comparisons of normally and nonnormally distributed continuous variables were performed with Student's *t* tests and Wilcoxon rank-sum tests, respectively. For each comparison, the null hypothesis was rejected for $P \leq 0.05$, without adjustment for multiple comparisons. Unless otherwise specified, data are expressed as mean \pm SD.

Results

Two hundred twenty-three patients were enrolled and randomized to receive standard discharge information (control, $n=116$) or standard discharge information plus the education intervention (education, $n=107$). Follow-up to the 180-day time period was complete for all patients. The baseline characteristics, shown in Table 1, demonstrate that the 2 study groups were evenly matched with respect to age, sex, presence of coronary artery disease, duration of heart failure, history of heart failure hospitalization, left ventricular ejection fraction, QRS interval, serum sodium level, heart rate, serum creatinine level, and 6-minute-walk distance. Additionally, similar percentages of control and education patients received follow-up care in general cardiology clinics and heart failure specialty clinics. Mean arterial blood pressure was higher in patients in the education group compared with controls.

The distribution of days hospitalized or dead in the 180-day follow-up period is shown in Figure 2. The number of days hospitalized or dead in the 180-day follow-up period, the primary study end point, was significantly lower ($P=0.009$) for the education group (1554 days; mean \pm SD, 14 ± 36 days; median and 75th percentile, 0 and 10 days) than for the control group (2103 days; mean \pm SD, 18 ± 37 days; median and 75th percentile, 4 and 19).

TABLE 1. Baseline Characteristics

	Control (n=116)	Education (n=107)	P
Age, y	64.7±13.9	65.0±14.6	0.76
Female, %	42	42	0.98
Race, % black	22	21	0.79
Coronary disease, %	63	64	0.97
Days since heart failure diagnosis	1345±1999	1492±2138	0.99
No. of hospitalizations, previous 12 months	3.0±2.6	2.8±2.8	0.28
Left ventricular ejection fraction, %	27±9	26±9	0.58
QRS interval, ms	125±39	129±38	0.34
Serum sodium, mEq/L	138±5	137±4	0.41
Heart rate, bpm	85±23	86±23	0.81
Mean arterial blood pressure, mm Hg	90±22	96±18	0.03
Blood urea nitrogen, mg/dL	35±18	34±18	0.81
Serum creatinine, mg/dL	1.6±0.7	1.6±0.7	0.68
Six-minute-walk distance, m	175±105	177±101	0.77
Follow-up in general cardiology clinic, %	68	65	0.67
Follow-up in heart failure specialty clinic, %	30	28	0.51

The combined end point of death or rehospitalization occurred in 64% of control and 47% of education patients. The time to first hospitalization or death was significantly longer for the education group ($P=0.012$, Figure 3). The relative risk of rehospitalization or death for the education intervention group was 0.65 (95% confidence interval [CI], 0.45 to 0.93; $P=0.018$), whereas the relative risk of rehospitalization due to heart failure was 0.49 (95% CI, 0.27 to 0.88; $P=0.015$) as shown in Table 2. No significant difference was observed in the end point of death for the education group ($n=7$, 6.5%) and the control group ($n=10$, 8.6%; $P=NS$). The adjusted relative risk of rehospitalization or death for the education intervention group was 0.66 (95% CI, 0.46 to 0.95; $P=0.025$), whereas the adjusted relative risk of rehospital-

ization due to heart failure was 0.56 (95% CI, 0.31 to 1.04; $P=0.065$).

Analysis of the treatment effect of the education intervention based on patient subgroups is shown in Figure 4. Tests for treatment interaction with patient subgroups (age, sex, race, presence of coronary disease, and follow-up with a heart failure specialist) revealed no significant relation between education intervention and the selected subgroups.

Table 3 shows the medical treatment for the study subjects at baseline (on admission) and at the 30-, 90-, and 180-day follow-up periods (surviving subjects). Patients in the education group were more likely to be treated with an angiotensin-converting enzyme (ACE) inhibitor at the end of follow-up compared with controls. Additionally, there were

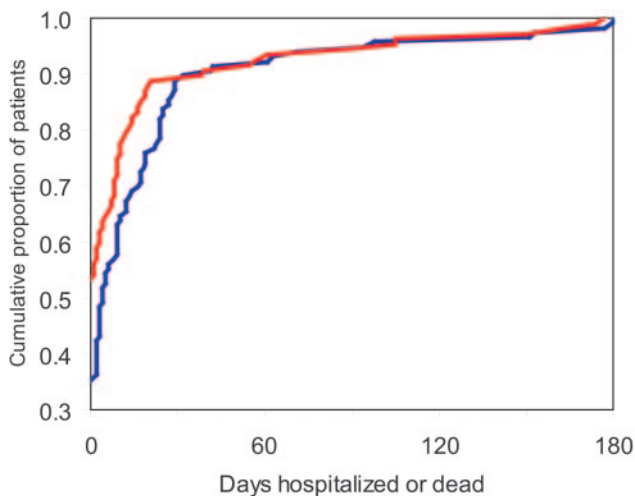


Figure 2. Days hospitalized or dead in 180-day follow-up period. Lines represent cumulative proportion of control (blue) and education (red) subjects. For Wilcoxon rank-sum comparison, $P=0.009$.

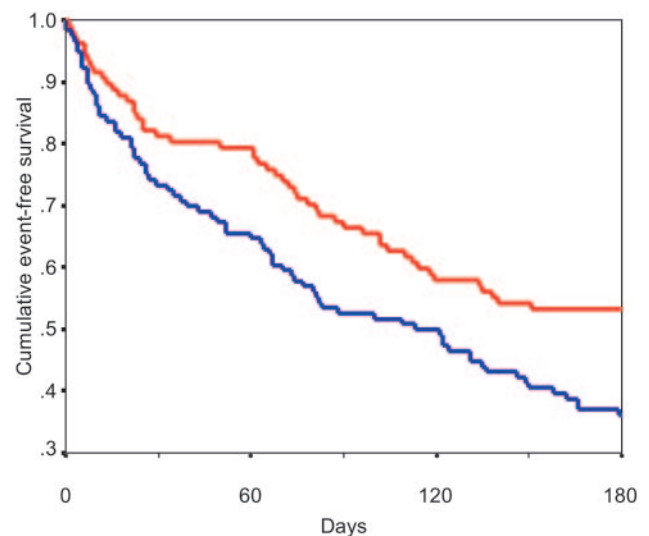


Figure 3. Event-free survival defined as time to first hospitalization or death for control (blue) and education (red) subjects. For log-rank comparison, $P=0.012$.

TABLE 2. Clinical Events

	Control, n (%)	Education, n (%)	RR (95% CI)	P
Death or hospitalization	74 (64)	50 (47)	0.65 (0.45, 0.93)	0.018
Heart failure hospitalization	33 (28)	16 (15)	0.49 (0.27, 0.88)	0.015
Cardiac hospitalization	54 (47)	34 (32)	0.59 (0.38, 0.91)	0.014
Death	10 (8.6)	7 (6.5)	0.94 (0.34, 2.6)	0.91

RR indicates relative risk. Other abbreviations are as defined in text.

significantly more patients in the education group on β -blocker therapy at 30-day follow-up, although this difference did not persist to the conclusion of follow-up. There were no differences in medical treatment with spironolactone or digoxin.

Patient-reported self-care practices 30 days after hospital discharge are shown in Table 4. Patients randomized to the education group were more likely to be weighing themselves daily, to be following a specific sodium restriction, and to be not smoking compared with controls. The self-care measures score (sum of the 6 self-care measurements) was significantly higher for the education group compared with controls.

Baseline MLHF scores for control (59 ± 22) and education (56 ± 23) subjects were similar. At the 30-day follow-up time point, MLHF scores were lower (ie, improved) in the education group (38 ± 22) compared with the control group (45 ± 25 , $P=0.049$). There was no difference in MLHF scores at the 180-day follow-up period between control (42 ± 25) and education (41 ± 22) subjects. Changes in MLHF scores from baseline to the 30-day follow-up period were significant for both control and education subjects. Changes in MLHF from baseline in control and education subjects at 30-day follow-up (15 ± 21 versus 18 ± 25 , $P=NS$) and at 180-day follow-up (18 ± 24 versus 13 ± 23 , $P=NS$) did not differ.

The average cost for hospital readmission during the 180-day follow-up period was $\$8292 \pm 11\,299$ for control subjects versus $\$5369 \pm 9096$ for education subjects ($P=0.034$). The cost of the intervention is estimated to be \$100 per subject (2 hours of nursing time at \$50 per hour). As a result, the overall cost of care

was higher in the control group by \$2823 (95% CI, \$202 to \$5644; $P=0.035$) per subject.

Discussion

Our results show that a patient-targeted heart failure education program delivered at hospital discharge leads to a reduction in the number of days hospitalized or dead in a 180-day follow-up period. The combined end point of rehospitalization or death was reduced in the patients exposed to the education intervention by 35% compared with controls. This combined end point was influenced largely by a 51% reduction in the need to be rehospitalized due to heart failure. This is the first demonstration that patient-targeted education delivered at the time of discharge leads to improved clinical outcomes in patients with systolic heart failure.

Improvements in clinical outcomes with the education intervention were accompanied by increases in heart failure patient-reported self-care practices. A significantly higher proportion of patients exposed to the education intervention reported weighing themselves daily, following a specific sodium restriction, and abstaining from cigarette smoking on 30-day follow-up compared with controls. Patients receiving heart failure education also showed a trend toward being more likely to follow other self-care measures. Whether these self-reported behaviors reflect the actual practices of the patients or were also influenced by differences in patient knowledge cannot be determined from this study.

Compared with baseline, medical therapy for patients in the education group demonstrated improvements compared

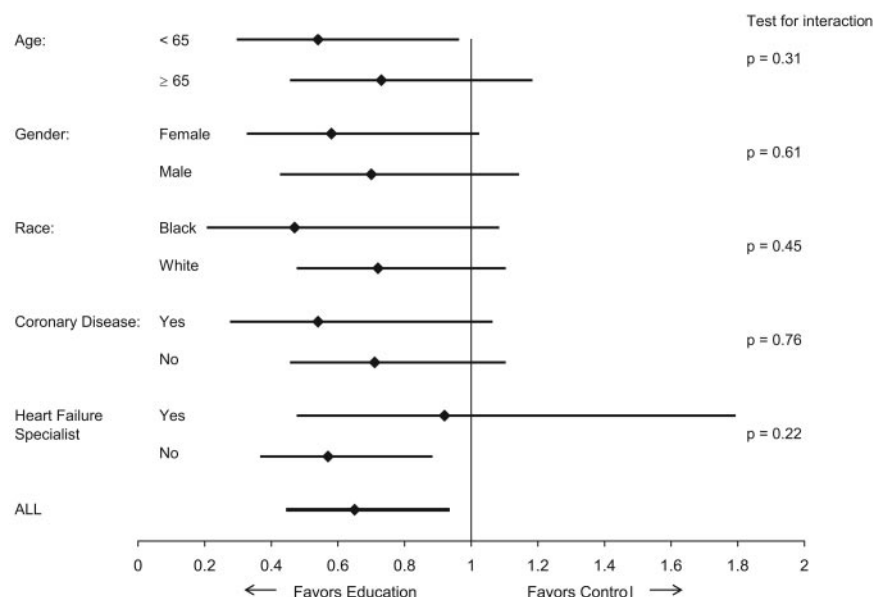


Figure 4. Relative risk ratios and 95% CIs for education vs control subjects with respect to patient subgroups.

TABLE 3. Medications

	Control/Education (<i>P</i>)			
	Baseline	30-Day Follow-Up	90-Day Follow-Up	180-Day Follow-Up
ACE inhibitor, %	52/59 (0.28)	68/78 (0.09)	66/78 (0.06)	60/74 (0.03)
ACE inhibitor or alternative, %	68/67 (0.90)	83/86 (0.53)	81/87 (0.31)	79/83 (0.46)
β -Blocker, %	59/64 (0.37)	68/83 (0.01)	74/81 (0.20)	73/77 (0.54)
Spironolactone, %	29/23 (0.32)	46/40 (0.32)	44/41 (0.60)	42/41 (0.90)
Digoxin, %	44/34 (0.12)	46/42 (0.48)	44/41 (0.60)	46/45 (0.80)

Alternative included angiotensin receptor blocker or combination of hydralazine and nitrates. Abbreviations are as defined in text.

P values are given for comparisons between control and education groups.

with control subjects with respect to ACE inhibitor therapy and β -blocker therapy. Although more patients in the education group were receiving β -blockers at 30-day follow-up, at the conclusion of study follow-up there were no significant differences in the 2 treatment groups. Only ACE inhibitor use differed significantly between the 2 groups at 180-day follow-up. Results from the SOLVD treatment trial show that enalapril treatment led to a 15% reduction in all-cause rehospitalization.¹¹ The MERIT-HF investigators reported a 19% risk reduction in the end point of death or rehospitalization with metoprolol succinate compared with placebo.¹² Given that these medications have been shown to have effects on death and rehospitalization, it is possible that this helps to explain why patients randomized to receive the education intervention demonstrated improved outcomes. It is also possible that the compliance rates for taking these medications were higher in the patients exposed to the education program. We did not measure compliance with prescribed medications in this study. We believe that the improvement in outcomes observed in this study was driven by better compliance with heart failure self-care measures, in addition to improvements in medical therapy created when the patient is made aware of appropriate guideline-based medical care.

Previous investigators have recognized the value of counseling, education, and lifestyle modifications in patients with heart failure due to left ventricular systolic dysfunction.¹³ Expert panels have supported the recommendation that patient education be provided as a matter of standard of care,^{3,13} and specific elements of information about self-care behavior have been defined to establish patient education as a key core measure of the quality of care provided to patients with heart failure.¹⁴ The specific content of patient education materials,

the amount of time and resources devoted to patient education, and the method of delivering the information to the patient have not been specified in any of these documents.

The benefits of heart failure medications and dietary interventions can only be realized when patients recognize their importance and comply with the prescribed treatment plan. Previous researchers have reported rates of noncompliance with medications ranging from 20% to 58% in patients with heart failure.^{15–18} Vinson et al¹⁹ reported that 27% of patients hospitalized for heart failure were rehospitalized within 90 days, and the majority of these hospitalizations resulted from medication or dietary noncompliance.

Neily et al²⁰ demonstrated that without specific instruction, many patients do not possess the knowledge base to follow a dietary sodium restriction, but this can be improved with dietary education. Linne and coauthors²¹ showed that a pharmacist-led, interactive-CD education program resulted in significant improvement in knowledge questionnaire scores in heart failure patients.

Efforts to study the effect of patient education on clinical outcomes in heart failure have largely included multidisciplinary approaches.^{4–8,22} Rich et al⁴ described the benefits of the first multidisciplinary heart failure program in 282 patients, which included a nurse-led discharge education session, a geriatrician cardiologist medication review, intensive follow-up with hospital home care services, heart failure nurse telephone management, a session with a dietitian, pharmacist medication education, and social services evaluation. This broad-based intervention resulted in a 44% reduction in the risk of rehospitalization compared with the control group. Using a more focused intervention, Stewart et al²² reported the effects of a home-based nurse/pharmacist education intervention in 97 patients discharged to home from acute hospital care. This intervention resulted in a dramatic reduction in unplanned hospital readmissions and fewer out-of-hospital deaths than in the control patients.

Jaarsma and colleagues²³ studied the effects of a patient education intervention taking place during the hospitalization and at a home visit within 1 week of discharge. No significant effects on resource utilization were found, although readmissions at 9 months in the intervention group were reduced compared with the control group (37% versus 50%). More recently, Krumholz et al⁸ published results of a randomized, controlled patient education and support intervention that included an hour-long, face-to-face session with a nurse

TABLE 4. Self-Care Practices at 30-Day Follow-Up

	Control, %	Education, %	<i>P</i>
Performing daily weigh-in	51	66	0.025
Following specific sodium restriction	20	32	0.050
Following specific fluid restriction	39	51	0.094
Not smoking	90	97	0.031
Reports plan for worsened symptoms	64	72	0.214
Performing exercise ≥ 3 times per week	33	46	0.060
Self-care practices score (of total of 6)	3.0 \pm 1.5	3.6 \pm 1.5	0.001

educator within 2 weeks of hospital discharge, followed by telephone contacts for a 1-year period. Among the 88 patients randomized into this study, significantly fewer patients in the intervention group experienced a hospital admission or died during the 1-year follow-up period.

The reduction in rehospitalizations found in the subjects randomized to the education intervention was associated with a \$2823 per-patient savings over the 180-day follow-up period. The per-patient savings in this study is less than that reported by investigators examining education interventions accompanied by postdischarge management strategies in similar patient populations. Krumholz et al⁸ demonstrated a \$7515 per-patient savings in hospital readmission costs with nurse-delivered, postdischarge education followed by regular nursing telephone contacts (intervention cost, \$530 per patient). Our data suggest that a significant portion of the savings demonstrated by relatively more complex interventions is due to the benefits of discharge education.

Similar benefits of education intervention were seen in patient subgroups based on age, sex, race, and presence of coronary artery disease. Patients receiving follow-up with a heart failure specialist may have less benefit from the program than do patients followed up by primary care physicians and/or general cardiologists. However, the statistical test for an interaction between the education intervention and physician follow-up type was not statistically significant, perhaps because of the small sample size of patients followed up by a heart failure specialist. It is possible that additional heart failure education would be less beneficial in these patients because at the University of Michigan, these patients receive similar education from their physician and assigned nurse case managers.

This study has several limitations, the first of which concerns the generalizability of the results. Of the 590 patients screened for study enrollment, 223 (38%) participated for this study. We did not study patients under evaluation for transplantation and made efforts not to enroll patients followed up by the University of Michigan Heart Failure Program. Patients who were residents of long-term-care facilities or who could not be followed up by telephone were also not included in our patient population. The effects of this discharge education program on patients with heart failure and preserved left ventricular function are not known. This is a topic for future study. The duration of the effect of the education program is also unclear from this study, because the follow-up time was limited to 180 days. Although we were able to demonstrate the benefits of a single discharge education session, we cannot comment on the effects of additional education sessions or on the effects of the discharge education session in a patient readmitted for heart failure after receiving the discharge education program.

A second limitation of the study is the absence of blinding of the nurse coordinator to the treatment assignment of the patients. The nurse conducting the telephone follow-up calls was aware of the treatment assignment, and this may have altered the answers given by the patients. To minimize this possibility, the nurse coordinator was advised to not discuss the treatment assignment after the discharge education ses-

sion. The telephone follow-up calls were scripted to ensure that the questions were identical for all subjects.

An additional limitation of the study is the lack of reliability of self-reported self-care measures. Patients exposed to the education program may have been more likely to know the correct behavior, but one cannot assume that these behaviors were practiced unless directly measured. Patient diaries for documentation of daily weights and dietary practices were not used in this study due to the concern that they would influence compliance independently of the discharge education program. Previous investigators have shown that patients with diabetes underreport dietary intake when compared with a "gold standard" method.²⁴ However, others have shown that self-reported behaviors, smoking in particular, are correlated closely with biochemical gold standards, especially if the information is acquired through a standard questionnaire.²⁵

Conclusion

In this study, patients hospitalized for the treatment of heart failure who received targeted patient education delivered by a nurse educator were less likely to be rehospitalized during a 180-day follow-up period. Patients exposed to the education program were also more likely to report appropriate, disease-specific, self-care practices. These improved outcomes were achieved at a substantial and significant reduction in costs. This is the first study to demonstrate the clinical benefit of a heart failure patient education program restricted to the hospital discharge time period. Patient education should be included in the optimal care of patients suffering from heart failure.

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